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CALCULATION PACKAGE COVER SHEET

Client: Gowanus Canal Remedial Design Group (RD Group) **Project:** Gowanus Canal Superfund Site **Project #:** HPH106A

TITLE OF PACKAGE: **RESULTS OF SIMULATED VERTICAL SPECIFIC DISCHARGE RATES FROM THE NATIVE ALLUVIAL SEDIMENTS AT THE 4TH STREET TURNING BASIN AFTER DREDGING, TARGETED REMOVAL OF NATIVE SEDIMENTS, CAPPING, AND BULKHEAD IMPROVEMENTS**

PREPARATION	**CALCULATION PREPARED BY:** (Calculation Preparer, CP)	Signature	Peter C Schillig	26 April 2017
		Name	Peter Schillig, Ph.D.	Date
REVIEW	**ASSUMPTIONS & PROCEDURES CHECKED BY:** (Assumptions & Procedures Checker, APC)	Signature	David J. Adilman	27 April 2017
		Name	David Adilman, P.G.	Date
	COMPUTATIONS CHECKED BY: (Computation Checker, CC)	Signature	Andrew Caiazzo	26 April 2017
		Name	Andrew Caiazzo	Date
BACK-CHECK	**BACK-CHECKED BY:** (Calculation Preparer, CP)	Signature	Peter C Schillig	19 May 2017
		Name	Peter Schillig, Ph.D.	Date
APPROVAL	**APPROVED BY:** (Calculation Approver, CA)	Signature	J.F. Beech	19 May 2017
		Name	J.F. Beech, Ph.D., P.E.	Date

REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA
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RESULTS OF SIMULATED VERTICAL SPECIFIC DISCHARGE RATES FROM THE NATIVE ALLUVIAL SEDIMENTS AT THE 4TH STREET TURNING BASIN AFTER DREDGING, TARGETED REMOVAL OF NATIVE SEDIMENTS, CAPPING, AND BULKHEAD IMPROVEMENTS

INTRODUCTION

This Data Package summarizes the procedure and assumptions used to simulate vertical specific discharge rates (L/T) into the Gowanus Canal's 4th Street Turning Basin. Model simulations were initially conducted, using a calibrated finite-difference three-dimensional groundwater flow model, under long-term average conditions with the soft sediment in place. A second model run was conducted to simulate the pilot scale remedy of the 4th Street Turning Basin which includes dredging of the soft sediments, targeted removal of native alluvial and glacial deposits, emplacement of a low hydraulic conductivity backfill, leveling layer and cap, and additional bulkhead support. These two simulations allow for a comparison of vertical specific discharge rates into the 4th Street Turning Basin before and after the proposed pilot remedy

DATA SOURCES AND METHODOLOGY

The Gowanus Canal steady-state flow model was calibrated under mean-tide conditions that were corrected to an equivalent freshwater head (see PD-12 Analysis Packages in Appendix E9 of the RTA1 35% Design Report). Additional data used to construct the model included Canal sediment layer thicknesses and hydraulic conductivity values from numerous borings and testing conducted within the Canal. The model was calibrated to tidally-averaged groundwater elevation data measured in upland monitoring wells (2010 conditions) and to average rates of long-term groundwater discharge into the Canal derived using vibrating wire piezometers and ultrasonic seepage meters from the PD-7 investigation (Geosyntec, 2016). The model layering within the Canal is discretized to allow simulation of spatially variable hydraulic conductivity values and simulate flow through the soft sediments, native alluvial sediments, and glacial deposits beneath the Canal.

The calibrated hydraulic conductivity values in 4th St. Turning Basin include:

Formation	Horizontal Hydraulic Conductivity (ft/d)	Vertical Hydraulic Conductivity (ft/d)	Anisotropy Ratio
soft sediment	4.5 to 2.3	0.5 to 0.3	10:1 to 8:1
native alluvial sediment	1.3 to 0.6	0.1 to 0.003	23:1 to 200:1
glacial deposits	71.1	16.5	4:1

The horizontal discretization of the finite difference grid in the Canal is 15 ft by 15 ft. Further details regarding the initial model construction and assumptions are presented in Appendix E9 of the RTA1 35% Design Report.

The calibrated groundwater model results include the calibrated hydraulic head at each model cell and the flow through each cell under steady-state conditions. The model was updated with increased recharge rates to better reflect long-term average precipitation rates compared to the calibrated condition which reflected lower than average precipitation rates. The model was also updated to include bulkhead improvements that had occurred in RTA1, RTA2, and the 4th Street Turning Basin after 2010. The bottom elevation of Model Layer 5 was extended from -40 ft NAVD88 to -50 ft NAVD88 to allow simulation of planned modifications and deepening of existing bulkheads. For the 4th Street Turning Basin, the average flow gradients are upward from the glacial deposits through the native alluvial and soft sediments and into the Canal. Because the model layering is discretized to simulate the glacial deposits, native alluvial and soft sediments separately, flow between units can be quantified. The total discharge rate from the native alluvial sediments (Model Layer 4) into the soft sediment (Model Layer 3) for each model cell was exported as vertical specific discharge (total upward flow rate divided by cell area) to shapefiles from the model environment and visualized using Geographic Information System software.

To perform the remedy simulation, (soft and targeted native alluvial/glacial sediment removal, backfill, leveling, and capping of the 4th St Turning Basin), the following steps were implemented:

1. The bottom of Model Layer 3 (i.e., soft sediment layer) was adjusted to represent the maximum design dredge elevation.

2. The bottom of Model Layer 2 (mudline or top of soft sediment) was adjusted to reflect the top elevation of a 28-inch thick cap above the backfill and leveling layers.

3. As a conservative measure to maximize the removal of low hydraulic conductivity sediments that control the specific discharge rate, the lowest design dredge elevation that falls within a Model Layer 3 cell boundary was retained as the bottom elevation of the cell. Locations where this revised bottom of Model Layer 3 was lower than the bottom elevation of Model Layer 4 (bottom of the native alluvial sediments and top of glacial), the dredging was interpreted to reach the underlying glacial deposits. This conservative approach led to the penetration of the glacial deposits in multiple model cells along the 3rd Avenue Bridge and the Whole Foods bulkhead. For simulation purposes, the glacial sediments were assumed to have been be penetrated during dredging; however, the actual dredging surfaces are not expected to penetrate the glacial deposits.

4. At locations where Model Layer 4 was less than 3 ft thick after dredging, a backfill layer with an isotropic hydraulic conductivity of 0.0283 ft/d (10^{-5} cm/s) material was applied and the bottom elevation of Model Layer 3 cells above these locations were adjusted until the minimum thickness of Model Layer 4 was 3 ft.

5. For this remedy simulation, targeted removal areas are represented in Layer 4 as a combination of remaining native alluvial sediment and backfill material of varying thicknesses. A composite hydraulic conductivity in the horizontal and vertical directions of Model Layer 4 was estimated by adding the product of hydraulic conductivity and respective percent thickness of the remaining native alluvial sediment and backfill that make up Model Layer 4.

6. The bottom elevation of Model Layer 2 was adjusted to -11.17 ft NAVD88 in the Canal to the west of the target removal of the native alluvial sediments/glacial deposits and east of the 3rd Avenue Bridge to accommodate the requisite cap thickness and low hydraulic conductivity backfill in Model Layers 3 and 4, respectively.

7. The bottom elevation of Model Layer 2 in the Canal was also adjusted to account for soft sediments removed west of the pilot study limits to allow for barge passage into and out of the pilot study area.

8. The horizontal and vertical hydraulic conductivity of Model Layer 3 was changed from values used to simulate the soft sediments into an isotropic 14.17 ft/d to reflect a sand-based leveling layer and cap design.

9. The hydraulic conductivity of existing bulkheads surrounding the perimeter of the turning basing was modified in Model Layers 2 to 4 to reflect the additional support of steel

sheetpiling and simulated tip elevations were further extended to the bottom of Model Layer 5. A new bulkhead was simulated along the 3rd Avenue Bridge from Model Layers 2 to 5. All new and modified bulkheads were simulated as horizontal flow barriers with a hydraulic conductivity of 0.00283 ft/d (10^{-6} cm/s).

As with the calibrated model, the total discharge rate from model Layer 4 was exported as vertical specific discharge to shapefiles from the model environment and visualized using Geographic Information System software.

SUMMARY OF RESULTS

Figure 1 shows the simulated vertical specific discharge rate between the native alluvial sediments (Layer 4) to Layer 3 for each model cell within the 4th Street Turning Basin prior to (Figure 1 top) and after implementation of the design remedy (Figure 1 bottom). The remedy model results indicate increased vertical specific discharge rates (Table 1) with the removal of the relatively low hydraulic conductivity soft and native alluvial sediments and replacement with a higher hydraulic conductivity leveling layer and cap. The inclusion of the relatively low hydraulic conductivity backfill below the leveling layer and cap in the simulated remedy limited increases in the simulated discharge rates, especially where the glacial deposits were penetrated in the model from dredging. Under steady-state conditions, the total upwelling discharge to the Canal in the 4th Street Turning Basin increases from 4.2 to 6.2 GPM after simulating the remedy implementation.

REFERENCES

Geosyntec (2016). "PD-7 Groundwater Upwelling Investigation Report, Gowanus Canal Superfund Site, Brooklyn, New York." Prepared by Geosyntec Consultants, Inc. and Beech and Bonaparte Engineering, P.C.

TABLES

Table 1
Modeled Specific Discharge from the 4th Street Turning Basin
Gowanus Canal Superfund Site
Brooklyn, New York

Geosyntec consultants
Beech and Bonaparte engineering p.c.
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Model Row	Model Column	Model Layer	Easting (ft)	Northing (ft)	Vertical Specific Discharge (ft/d)		
					Upgraded Calibrated Groundwater Model	Post Remedy	Percent Difference
235	289	4	633445.38	671144.65	0.0373	0.0360	-3.55%
235	290	4	633452.19	671158.02	0.0190	0.0211	10.47%
235	291	4	633459.00	671171.38	0.0204	0.0232	12.84%
235	292	4	633465.81	671184.75	0.0212	0.0274	25.51%
235	293	4	633472.62	671198.11	0.0211	0.0234	10.34%
235	294	4	633479.42	671211.48	0.0204	0.0225	9.79%
235	295	4	633486.23	671224.84	0.0185	0.0207	11.22%
235	296	4	633493.04	671238.21	0.0274	0.0261	-4.86%
236	289	4	633456.22	671139.13	0.0353	0.0365	3.34%
236	290	4	633463.03	671152.49	0.0180	0.0235	26.51%
236	291	4	633469.84	671165.86	0.0191	0.0252	27.54%
236	292	4	633476.65	671179.22	0.0203	0.0282	32.58%
236	293	4	633483.46	671192.59	0.0187	0.0250	28.83%
236	294	4	633490.27	671205.95	0.0183	0.0227	21.46%
236	295	4	633497.08	671219.32	0.0157	0.0200	24.09%
237	289	4	633469.63	671132.30	0.0174	0.0229	27.30%
237	290	4	633476.43	671145.66	0.0178	0.0231	25.92%
237	291	4	633483.24	671159.03	0.0195	0.0255	26.67%
237	292	4	633490.05	671172.39	0.0180	0.0231	24.82%
237	293	4	633496.86	671185.76	0.0166	0.0220	27.98%
237	294	4	633503.67	671199.12	0.0160	0.0205	24.66%
237	295	4	633510.48	671212.49	0.0142	0.0178	22.50%
238	289	4	633485.60	671124.16	0.0173	0.0225	26.13%
238	290	4	633492.41	671137.52	0.0179	0.0228	24.08%
238	291	4	633499.22	671150.89	0.0187	0.0235	22.75%
238	292	4	633506.03	671164.25	0.0173	0.0217	22.56%
238	293	4	633512.84	671177.62	0.0149	0.0193	25.73%
238	294	4	633519.65	671190.98	0.0145	0.0187	25.30%
238	295	4	633526.46	671204.35	0.0147	0.0171	15.09%
239	289	4	633500.84	671116.39	0.0173	0.0222	24.81%
239	290	4	633507.65	671129.76	0.0173	0.0216	22.11%
239	291	4	633514.46	671143.12	0.0186	0.0229	20.72%
239	292	4	633521.27	671156.49	0.0162	0.0200	20.99%
239	293	4	633528.08	671169.85	0.0146	0.0179	20.31%
239	294	4	633534.89	671183.22	0.0140	0.0170	19.35%
239	295	4	633541.70	671196.58	0.0273	0.0495	57.81%
240	289	4	633515.33	671109.01	0.0171	0.0217	23.71%
240	290	4	633522.14	671122.37	0.0171	0.0210	20.47%
240	291	4	633528.95	671135.74	0.0179	0.0215	18.27%
240	292	4	633535.76	671149.10	0.0157	0.0191	19.54%
240	293	4	633542.57	671162.47	0.0144	0.0175	19.44%
240	294	4	633549.38	671175.83	0.0137	0.0164	17.94%
240	295	4	633556.19	671189.20	0.0382	0.0366	-4.28%
241	289	4	633529.82	671101.62	0.0169	0.0212	22.57%
241	290	4	633536.63	671114.99	0.0167	0.0203	19.46%
241	291	4	633543.44	671128.36	0.0167	0.0195	15.47%
241	292	4	633550.25	671141.72	0.0148	0.0176	17.28%
241	293	4	633557.06	671155.09	0.0141	0.0166	16.29%
241	294	4	633563.87	671168.45	0.0132	0.0158	17.93%
241	295	4	633570.68	671181.82	0.0381	0.0363	-4.84%
242	289	4	633544.31	671094.24	0.0168	0.0209	21.75%
242	290	4	633551.12	671107.61	0.0163	0.0192	16.34%
242	291	4	633557.93	671120.97	0.0150	0.0176	15.95%
242	292	4	633564.74	671134.34	0.0130	0.0151	14.95%
242	293	4	633571.55	671147.70	0.0132	0.0156	16.67%
242	294	4	633578.36	671161.07	0.0126	0.0155	20.64%
242	295	4	633585.17	671174.43	0.0382	0.0364	-4.83%
243	289	4	633558.81	671086.86	0.0165	0.0364	75.24%
243	290	4	633565.62	671100.22	0.0159	0.0314	65.54%

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Model Row	Model Column	Model Layer	Easting (ft)	Northing (ft)	Vertical Specific Discharge (ft/d)		
					Upgraded Calibrated Groundwater Model	Post Remedy	Percent Difference
243	291	4	633572.43	671113.59	0.0145	0.0288	66.05%
243	292	4	633579.24	671126.95	0.0133	0.0185	32.70%
243	293	4	633586.05	671140.32	0.0130	0.0154	16.90%
243	294	4	633592.86	671153.68	0.0126	0.0154	20.00%
243	295	4	633599.67	671167.05	0.0383	0.0310	-21.07%
244	289	4	633573.30	671079.47	0.0159	0.0358	76.98%
244	290	4	633580.11	671092.84	0.0145	0.0273	61.24%
244	291	4	633586.92	671106.20	0.0149	0.0291	64.55%
244	292	4	633593.73	671119.57	0.0132	0.0219	49.57%
244	293	4	633600.54	671132.93	0.0127	0.0151	17.27%
244	294	4	633607.35	671146.30	0.0126	0.0153	19.35%
244	295	4	633614.16	671159.66	0.0385	0.0311	-21.26%
245	289	4	633587.79	671072.09	0.0158	0.0339	72.84%
245	290	4	633594.60	671085.45	0.0142	0.0261	59.06%
245	291	4	633601.41	671098.82	0.0120	0.0171	35.05%
245	292	4	633608.22	671112.18	0.0124	0.0177	35.22%
245	293	4	633615.03	671125.55	0.0125	0.0145	14.81%
245	294	4	633621.84	671138.91	0.0124	0.0151	19.64%
245	295	4	633628.65	671152.28	0.0384	0.0701	58.43%
246	289	4	633602.29	671064.70	0.0162	0.0356	74.90%
246	290	4	633609.10	671078.07	0.0134	0.0223	49.86%
246	291	4	633615.90	671091.43	0.0125	0.0191	41.77%
246	292	4	633622.71	671104.80	0.0121	0.0158	26.52%
246	293	4	633629.52	671118.16	0.0120	0.0142	16.79%
246	294	4	633636.33	671131.53	0.0124	0.0154	21.58%
247	289	4	633616.78	671057.32	0.0155	0.0197	23.86%
247	290	4	633623.59	671070.68	0.0134	0.0159	17.06%
247	291	4	633630.40	671084.05	0.0125	0.0144	14.13%
247	292	4	633637.21	671097.41	0.0125	0.0142	12.73%
247	293	4	633644.02	671110.78	0.0125	0.0149	17.52%
247	294	4	633650.83	671124.14	0.0124	0.0159	24.73%
248	289	4	633631.27	671049.93	0.0166	0.0201	19.07%
248	290	4	633638.08	671063.30	0.0145	0.0161	10.46%
248	291	4	633644.89	671076.66	0.0137	0.0149	8.39%
248	292	4	633651.70	671090.03	0.0136	0.0151	10.45%
248	293	4	633658.51	671103.39	0.0136	0.0219	46.76%
248	294	4	633665.32	671116.76	0.0137	0.0233	51.89%
249	289	4	633645.76	671042.55	0.0168	0.0196	15.38%
249	290	4	633652.57	671055.91	0.0155	0.0171	9.82%
249	291	4	633659.38	671069.28	0.0145	0.0154	6.02%
249	292	4	633666.19	671082.64	0.0146	0.0298	68.47%
249	293	4	633673.00	671096.01	0.0152	0.0545	112.77%
249	294	4	633679.81	671109.38	0.0160	0.0600	115.79%
250	288	4	633653.45	671021.80	0.0013	0.0072	138.82%
250	289	4	633660.26	671035.17	0.0011	0.0023	70.59%
250	290	4	633667.07	671048.53	0.0010	0.0015	40.00%
250	291	4	633673.88	671061.90	0.0010	0.0021	70.97%
250	292	4	633680.69	671075.26	0.0011	0.0029	90.00%
250	293	4	633687.50	671088.63	0.0011	0.0058	136.23%
250	294	4	633694.31	671101.99	0.0026	0.0323	170.20%
251	288	4	633667.94	671014.42	0.0014	0.0281	181.02%
251	289	4	633674.75	671027.78	0.0012	0.0140	168.42%
251	290	4	633681.56	671041.15	0.0012	0.0031	88.37%
251	291	4	633688.37	671054.51	0.0013	0.0058	126.76%
251	292	4	633695.18	671067.88	0.0013	0.0116	159.69%
251	293	4	633701.99	671081.24	0.0013	0.0162	170.29%
251	294	4	633708.80	671094.61	0.0027	0.0324	169.23%
252	288	4	633682.43	671007.03	0.0015	0.0326	182.40%
252	289	4	633689.24	671020.40	0.0013	0.0221	177.78%
252	290	4	633696.05	671033.76	0.0015	0.0140	161.29%
252	291	4	633702.86	671047.13	0.0014	0.0093	147.66%

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Model Row	Model Column	Model Layer	Easting (ft)	Northing (ft)	Vertical Specific Discharge (ft/d)		
					Upgraded Calibrated Groundwater Model	Post Remedy	Percent Difference
252	292	4	633709.67	671060.49	0.0014	0.0105	152.94%
252	293	4	633716.48	671073.86	0.0015	0.0232	175.71%
252	294	4	633723.29	671087.22	0.0027	0.0325	169.32%
253	288	4	633696.92	670999.65	0.0016	0.0327	181.34%
253	289	4	633703.73	671013.01	0.0015	0.0279	179.59%
253	290	4	633710.54	671026.38	0.0017	0.0210	170.04%
253	291	4	633717.35	671039.74	0.0016	0.0152	161.90%
253	292	4	633724.16	671053.11	0.0014	0.0047	108.20%
253	293	4	633730.97	671066.47	0.0018	0.0279	175.76%
253	294	4	633737.78	671079.84	0.0028	0.0327	168.45%
254	288	4	633711.42	670992.26	0.0017	0.0283	177.33%
254	289	4	633718.23	671005.63	0.0018	0.0326	179.07%
254	290	4	633725.04	671018.99	0.0018	0.0222	170.00%
254	291	4	633731.85	671032.36	0.0017	0.0059	110.53%
254	292	4	633738.66	671045.72	0.0016	0.0082	134.69%
254	293	4	633745.47	671059.09	0.0021	0.0188	159.81%
254	294	4	633752.28	671072.45	0.0028	0.0329	168.63%
255	288	4	633725.91	670984.88	0.0020	0.0327	176.95%
255	289	4	633732.72	670998.24	0.0023	0.0281	169.74%
255	290	4	633739.53	671011.61	0.0022	0.0269	169.76%
255	291	4	633746.34	671024.97	0.0017	0.0327	180.23%
255	292	4	633753.15	671038.34	0.0021	0.0235	167.19%
255	293	4	633759.96	671051.70	0.0026	0.0026	0.00%
256	288	4	633740.40	670977.49	0.0022	0.0328	174.86%
256	289	4	633747.21	670990.86	0.0027	0.0328	169.58%
256	290	4	633754.02	671004.22	0.0030	0.0328	166.48%
256	291	4	633760.83	671017.59	0.0022	0.0258	168.57%
256	292	4	633767.64	671030.95	0.0028	0.0328	168.54%
256	293	4	633774.45	671044.32	0.0033	0.0180	138.03%
257	287	4	633748.09	670956.74	0.0026	0.0332	170.95%
257	288	4	633754.90	670970.11	0.0025	0.0329	171.75%
257	289	4	633761.70	670983.47	0.0039	0.0329	157.61%
257	290	4	633768.51	670996.84	0.0038	0.0329	158.58%
257	291	4	633775.32	671010.20	0.0032	0.0329	164.54%
257	292	4	633782.13	671023.57	0.0033	0.0224	148.64%
257	293	4	633788.94	671036.93	0.0039	0.0180	128.77%
258	287	4	633762.58	670949.36	0.0027	0.0333	170.00%
258	288	4	633769.39	670962.72	0.0028	0.0330	168.72%
258	289	4	633776.20	670976.09	0.0047	0.0330	150.13%
258	290	4	633783.01	670989.46	0.0044	0.0330	152.94%
258	291	4	633789.82	671002.82	0.0044	0.0330	152.94%
258	292	4	633796.63	671016.19	0.0042	0.0248	142.07%
258	293	4	633803.44	671029.55	0.0050	0.0192	117.36%
259	287	4	633777.07	670941.98	0.0030	0.0228	153.49%
259	288	4	633783.88	670955.34	0.0029	0.0284	162.94%
259	289	4	633790.69	670968.71	0.0037	0.0331	159.78%
259	290	4	633797.50	670982.07	0.0040	0.0284	150.62%
259	291	4	633804.31	670995.44	0.0049	0.0284	141.14%
259	292	4	633811.12	671008.80	0.0053	0.0237	126.90%
259	293	4	633817.93	671022.17	0.0064	0.0205	104.83%
260	287	4	633791.56	670934.59	0.0035	0.0097	93.94%
260	288	4	633798.37	670947.96	0.0033	0.0191	141.07%
260	289	4	633805.18	670961.32	0.0034	0.0249	151.94%
260	290	4	633811.99	670974.69	0.0040	0.0331	156.87%
260	291	4	633818.80	670988.05	0.0063	0.0284	127.38%
260	292	4	633825.61	671001.42	0.0068	0.0273	120.23%
260	293	4	633832.42	671014.78	0.0075	0.0264	111.50%

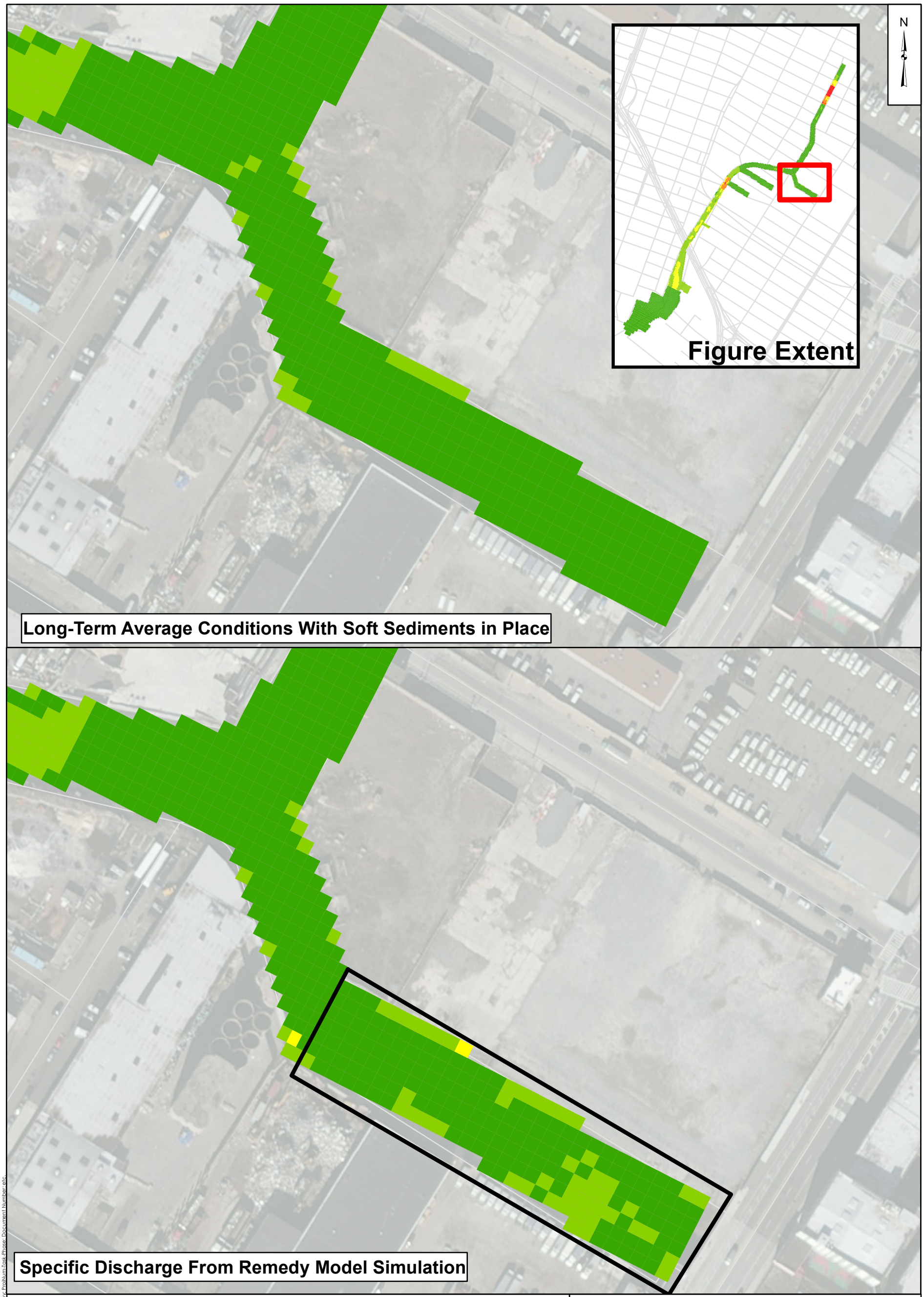
Table 1
Modeled Specific Discharge from the 4th Street Turning Basin
Gowanus Canal Superfund Site
Brooklyn, New York

Geosyntec consultants
Beech and Bonaparte engineering p.c.
an affiliate of Geosyntec Consultants

Model Row	Model Column	Model Layer	Easting (ft)	Northing (ft)	Vertical Specific Discharge (ft/d)		
					Upgraded Calibrated Groundwater Model	Post Remedy	Percent Difference
261	287	4	633806.06	670927.21	0.0040	0.0098	84.06%
261	288	4	633812.87	670940.57	0.0042	0.0120	96.30%
261	289	4	633819.68	670953.94	0.0032	0.0332	164.84%
261	290	4	633826.49	670967.30	0.0057	0.0285	133.33%
261	291	4	633833.30	670980.67	0.0081	0.0261	105.26%
261	292	4	633840.11	670994.03	0.0080	0.0262	106.43%
261	293	4	633846.92	671007.40	0.0083	0.0265	104.60%
262	287	4	633820.55	670919.82	0.0047	0.0265	139.74%
262	288	4	633827.36	670933.19	0.0048	0.0286	142.51%
262	289	4	633834.17	670946.55	0.0050	0.0333	147.78%
262	290	4	633840.98	670959.92	0.0089	0.0238	91.13%
262	291	4	633847.79	670973.28	0.0088	0.0250	95.86%
262	292	4	633854.60	670986.65	0.0086	0.0250	97.62%
262	293	4	633861.41	671000.01	0.0094	0.0253	91.64%
263	287	4	633835.04	670912.44	0.0055	0.0253	128.57%
263	288	4	633841.85	670925.80	0.0058	0.0263	127.73%
263	289	4	633848.66	670939.17	0.0066	0.0286	125.00%
263	290	4	633855.47	670952.53	0.0093	0.0227	83.75%
263	291	4	633862.28	670965.90	0.0092	0.0239	88.82%
263	292	4	633869.09	670979.26	0.0095	0.0251	90.17%
263	293	4	633875.90	670992.63	0.0029	0.0336	168.22%
264	287	4	633849.53	670905.05	0.0038	0.0338	159.57%
264	288	4	633856.34	670918.42	0.0034	0.0336	163.24%
264	289	4	633863.15	670931.78	0.0073	0.0287	118.89%
264	290	4	633869.96	670945.15	0.0080	0.0264	106.98%
264	291	4	633876.77	670958.51	0.0101	0.0241	81.87%
264	292	4	633883.58	670971.88	0.0103	0.0253	84.27%
264	293	4	633890.39	670985.24	0.0030	0.0338	167.39%

Notes:
1. Vertical specific discharges were exported from Layer 4 in the steady-state groundwater flow model (10/19/2016) that was upgraded (2/16/2017) to include increased recharge rates that better reflect long-term average conditions and known bulkhead improvements since 2010.
2. Specific discharges represent mean tide conditions with the soft and native alluvial sediments in place for the upgraded base model simulation and with the soft sediment removal, targeted native alluvial sediment removal, capping, and bulkhead upgrades for the remedy model simulation.
3. ft/d = feet per day.
4. Positive specific discharge values signify upward flow rates.
5. A positive percent difference indicates that the vertical specific discharge was greater for the after remedy scenario relative to the upgraded base model.

FIGURE



Legend

Specific Discharge (ft/d)

- 0.001 - 0.03
- 0.03 - 0.06
- 0.07 - 0.13
- 0.14 - 0.29
- 0.30 - 0.66

Approximate Limits of Pilot Study

Notes:

1. Vertical specific discharges were exported from Layer 4 in the steady-state groundwater flow model (10/19/2016) that was upgraded to included increased recharge rates that better reflect long-term average conditions and known bulkhead improvements since 2010.
2. Specific discharges represent mean tide conditions with the soft and native alluvial sediments in place for the upgraded base model simulation and with the targeted native alluvial sediment removal dredging, capping, and bulkhead upgrades for the remedy model simulation.
3. ft/d = feet per day.
4. Each square of grid in Canal represents an area 15 feet by 15 feet.
5. The maximum vertical specific discharge within the limits of the pilot study in Layer 4 for pre and post remedy were approximately 0.04 ft/d and 0.07 ft/d, respectively.

120 60 0 120 Feet

Groundwater Model Simulated Upward Specific Discharge Rates into the 4th Street Turning Basin

Gowanus Canal Pre-Design Investigation, Brooklyn, NY

Gowanus Canal Remedial Design Group

Geosyntec consultants

Beech and Bonaparte engineering p.c.
an affiliate of Geosyntec Consultants

Ewing, NJ | May 2017

Figure 1

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